# LOW TEMPERATURE EVALUATION OF THE UCC3588 5-BIT PROGRAMMABLE OUTPUT POWER SUPPLY CONTROLLER

Test Report

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## Background

The Texas Instrument/Unitrode UCC3588 is a BiCMOS power controller chip for synchronous step-down (Buck) dc-dc converter applications[1]. This device was identified and selected for evaluation for potential use in the development of a low temperature dc-dc converter module. The performance of the BiCMOS-structure devices at low temperature is questionable. Typically, CMOS devices perform relatively well down to approximately liquid nitrogen temperature (-196 °C). Bipolar devices, on the other hand, are known to suffer performance degradation at low temperature. BiCMOS devices are a hybrid of these two families and as such may or may not perform well at low temperatures.

## Test Setup

Two circuit boards, each populated with the UCC3588 chip and few passive components, were designed and built for evaluation in the temperature range of +25 °C to -190 °C. Performance characterization included switching frequency, duty cycle, and dead-time. The UCC3588 programmable controller was tested under the following conditions:

- Oscillator frequency set to 100 kHz by a 150 KΩ resistor
- The external voltage feedback was provided manually
- Current sense disabled (shorted to Vsense)
- 5-Bit programming set for 3V output
- Vsense set to 3V (by a power supply)
- Compensation pin tied to voltage feedback pin

This configuration yielded a duty cycle control in the range of 0 to 100% at both output terminals of the controller.

## Results and Discussion

Both devices began to show intermittent high frequency jitter to the normal 100 kHz switching frequency at -25 °C, as shown in Figure 1. This jitter seemed to increase in both amplitude and occurrence as temperature was decreased further. The two devices did not perform well with the low temperature exposure as both experienced catastrophic failures. While one of the device failed at -125 °C, the other ceased operation at temperatures around -60 °C. The effect of low temperature exposure on the device's performance was profound as was evident by the dramatic changes in the device output parameters. These changes, which became more severe as temperature was decreased further, have eventually led to a complete failure of the device. The low temperature-induced effects included:

- A decrease in switching frequency
- A decrease in dead-time
- An increase in duty cycle for a set voltage feedback
- A slight shift in programmed output voltage
- Eventual catastrophic device failure

## Conclusion

The UCC3588 programmable power supply controller, which is a commercial-grade rated for 0 to 70 °C operation, did not perform well at temperatures of -25 °C and below. The two devices investigated in this work have sustained failures at test temperatures of -60 °C and -125 °C, respectively. Future work may involve evaluating military-grade devices that are rated in operation temperature from -55 °C to 125 °C.

## References

1. UCC3588 5-Bit Programmable Output BiCMOS Power Supply Controller Data Sheet, Texas Instruments, Inc.

## Acknowledgments

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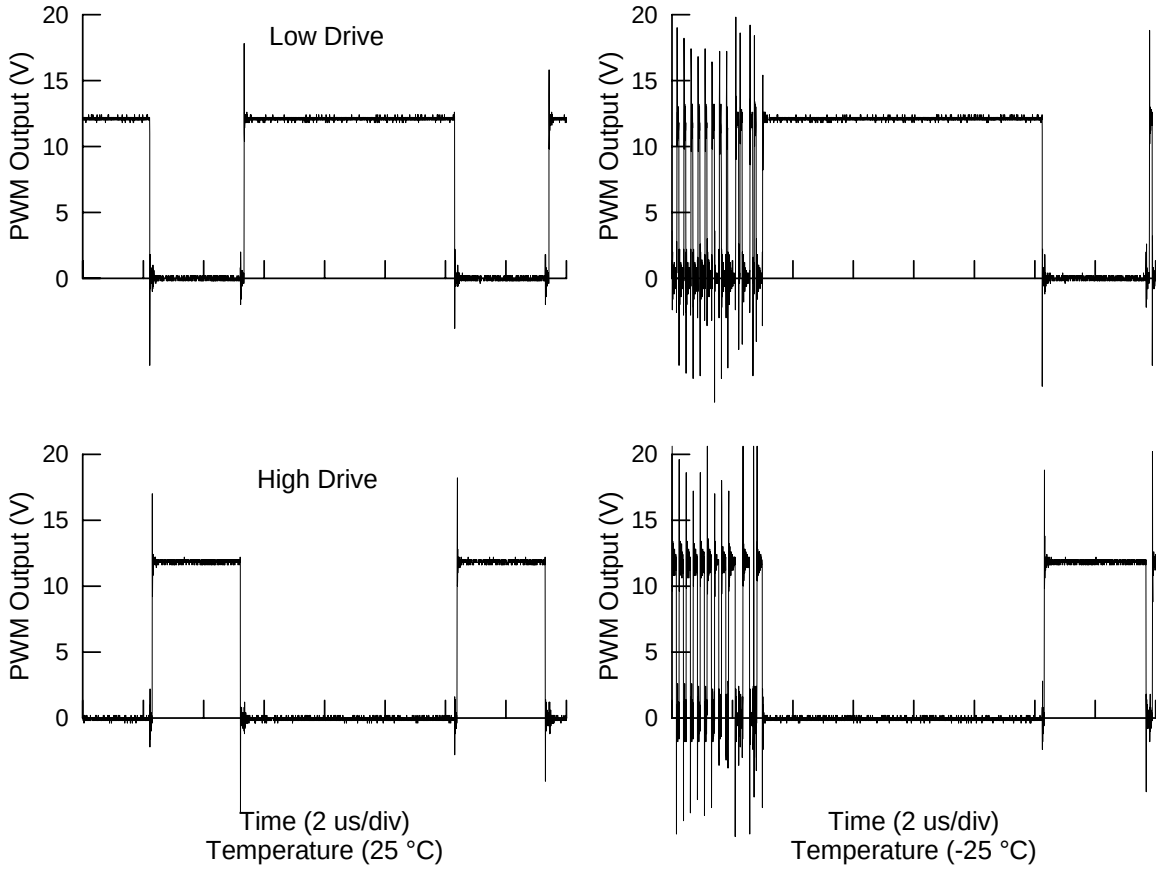


Figure 1. Waveforms of the UCC3588 two pulse width modulation (PWM) outputs at +25 °C (left side) and -25 °C (right side).